इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 13344 (1992): Method for checking the bias of sampling of ores [MTD 13: Ores and Raw Materials]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

IS 13344 : 1992
(Reaffirmed 2003)

भारतीय मानक

अयस्कों के नमूने लेने के बायस की जाँच की पद्धतियाँ

Indian Standard

METHODS FOR CHECKING THE BIAS OF SAMPLING OF ORES

UDC 622·3 : 620·113

© BIS 1992

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

May 1992

Price Group 3

Sampling of Ores, Metallurgical and Allied Products Sectional Committee, BSD 7

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Sampling of Ores, Metallurgical and Allied Products Sectional Committee had been approved by the Basic Standards, Systems and Services Division Council.

The object of this standard is to specify experimental methods for checking the bias of sampling of ores.

In preparation of this standard assistance has been drawn from ISO 3086 : 1986 'Iron ores — experimental methods for checking the bias of sampling' published by International Organization for Standardization (ISO). Also, Table 1 and Table 2, as given in the standard, have been taken from DAVIES, (O L) Ed.; The Design and Analysis of Industrial Experiments, 1956, pp. 606-607 and JSA Statistical Tables and Formulas with Computer Applications, Tokyo; Japanese Standards Association, 1972, respectively.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

METHODS FOR CHECKING THE BIAS OF SAMPLING OF ORES

1 SCOPE

This standard specifies experimental methods for checking the bias of sampling of ores, when the sampling is carried out in accordance with the methods specified in respective Indian Standards.

2 REFERENCE

The following Indian Standard is a necessary adjunct to this standard:

IS No.	*Title*
6200 (Part 1) : 1977	Statistical tests of significance : Part 1 *t*-, Normal and *F*-tests (*first revision*)

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 True Value

It is an ideal value which could be arrived at only if all causes of errors are eliminated.

3.2 Overall Precision

The overall precision, β_{SDM}, is a measure of the combined precision of sampling, sample division and measurement, and is twice the overall precision in terms of standard deviation, σ_{SDM} expressed as an absolute percentage:

$$\beta_{SDM} = 2\,\sigma_{SDM} = 2\sqrt{\sigma_S^2 + \sigma_D^2 + \sigma_M^2}$$

where

σ_S = precision of sampling in terms of standard deviation;

σ_D = precision of sample division in terms of standard deviation; and

σ_M = precision of measurement in terms of standard deviation.

3.3 Bias

A measure of systematic departure of test results from the true value. It is expressed as the difference between the mean results and the true value.

3.4 Confidence Interval

The interval between two values such that the probability of the interval including the true value of the parameter is fixed.

3.5 Confidence Level

The value of the probability associated with a confidence interval or a statistical tolerance interval.

4 GENERAL CONDITIONS

4.1 In the experimental methods given here, the results obtained from the method to be checked (referred to as Method B) are compared with the results of a reference method (referred to as Method A) which is considered to produce practically unbiased results, from technical and empirical viewpoints.

4.2 In the event that there is no significant difference in a statistical sense between the results obtained by Method B and Method A, this Method B may be adopted as a routine method subject to the agreement between the parties concerned.

NOTE — In this standard, bias is assessed by application of the *t*-tests (one sided) at 5 percent level of significance, by determining whether the difference between the results obtained under Method A and Method B is due to random causes or whether the results are statistically different.

4.3 The number of lots or sub-lots for experimentation shall not be less than 20. The number of tests required depends on the standard deviation of the difference based on 20 tests and also the agreed value of the bias, δ. The value of the bias to be detected shall be fixed by agreement between the parties concerned, taking into account the technical and economic considerations, the various precisions of the methods to be adopted in the experiment, namely, sampling, sample preparation and measurement precisions. As a guide, a bias value of half the overall precision, i. e, β_{SDM}, may be appropriate unless otherwise agreed. (The value of overall precision β_{SDM} for lot sizes up to 15 000 tonnes would be ± 0·5 and for higher tonnage ±0·4 of total iron content. For other ores different values may be agreed upon). For detailed explanation of β_{SDM}, *see* Annex A.

4.4 Quality characteristics such as the content of the principal element, moisture content, size percentage and physical properties may be assessed for checking the bias between the standard method and the reference method.

4.5 The method for analysis of experimental data described here may also be applied for checking a possible significant difference in the result obtained from the samples of one lot sampled at two different places, for example, a loading point and a discharging point.

5 SAMPLING AND SAMPLE PREPARATION METHODS

5.1 Sampling

When the ore is carried out on conveyer belt, the reference method for checking the bias of sampling is the stopped-belt method. The method to be checked (Method B) may be any other method proposed to be used under specific conditions and this is to be checked with Method A.

When the ore is received or despatched in trucks or wagons, the reference method is the one where samples are collected (with suitable sampling implements) during loading or unloading of wagons or trucks. The Method B in this situation may be any other method used for sampling from wagons or trucks.

5.2 Any departure in the collection of increments from the standard method may also be subjected to the verification of bias by this method. For instance, using the sampling implement other than the prescribed one, a change in the frequency of sampling without affecting the total number of increments, are some of the examples for departure from standard method of sampling. It is, however, to be noted that there should not be too many deviations from this standard method and it is always advisable to have only one aspect of departure from the test method tested for bias as per the experimental procedures.

5.3 Sample Preparation

Methods for making up a pair of gross samples, preparation of samples and testing shall be as given in **5.3.1** to **5.3.3**.

5.3.1 Increments obtained from one sub-lot in accordance with Method A and Method B are made up in two gross samples A and B. If the number of sub-lots in a lot are not sufficient for the experiment, a suitable number of lots may be subjected to this experimentation so that the total number of sub-lots (the total number of pairs) do exceed 20.

5.3.2 The gross samples A and B are subjected in the same manner to sample preparation as per the respective Indian Standards on sampling and testing.

5.3.3 Number of experiments can be conducted along with routine sampling so that there is no extraneous element of precaution involved in experimental results. In other words, both the methods, namely, Method A and Method B can be simultaneously adopted in the course of sampling of ores. This, of course, is not possible in a number of situations when the Method A is a stopped-belt method and the Method B may involve sampling far away from the conveyer belt.

6 ANALYSIS OF EXPERIMENTAL DATA

6.1 Denote individual measurements obtained in accordance with Method A and Method B as x_{Ai} and x_{Bi}, respectively.

Calculate the difference d_i between x_{Ai} and x_{Bi} as

$$d_i = x_{Bi} - x_{Ai},\ i = 1, 2, \cdots \cdots, k$$

where k is the number of paired sets of measurements. It may be noted that d_i can be both positive as well as negative.

6.2 Calculate the mean $\bar{d}$ of the differences to one decimal place further than that used in the measurements themselves.

$$\bar{d} = \frac{1}{k} \Sigma d_i$$

Calculate the standard deviation by the following formula:

$$s_d = \sqrt{\frac{\Sigma d_i^2 - 1/k\ (\Sigma d_i)^2}{k - 1}}$$

6.3 Determination of the Required Number of Lots for the Experiment (n_r)

6.3.1 Calculate the value of the standardized difference D using the equation

$$D = \delta / s_d$$

Then determine from Table 1 the value of n_r corresponding to the value of D.

6.3.2 When $n_r < 20$, proceed as in **6.4**. When $n_r > 20$, carry out the additional experiments on ($n_r - 20$) sub-lots.

6.3.3 This procedure shall be repeated until the number of pairs of sets of data becomes equal to or more than the value of n_r specified in Table 1.

6.4 Statistical Test

Calculate the value of t_0 to the third decimal place by rounding off the fourth decimal place.

$$t_0 = \frac{\bar{d}}{s_d / \sqrt{k}}$$

When the absolute value of t_0 is smaller than the value of t corresponding to k as given in Table 2, conclude that the difference is not significant and that Method B can be adopted as a routine method. When t_0 is greater than the value of t given in Table 2, we have to infer that the difference is significant and the Method B cannot be used as a routine method.

Table 1 Required Number of Paired Sets of Data, n_r, Determined by the Value of the Standardized Difference, D

(*Clauses* 6.3.1 *and* 6.3.3)

Range of Standardized Difference, D	Required Number of Paired Sets of Data, n_r
$0{\cdot}30 < D < 0{\cdot}35$	122
$0{\cdot}35 < D < 0{\cdot}40$	90
$0{\cdot}40 < D < 0{\cdot}45$	70
$0{\cdot}45 < D < 0{\cdot}50$	55
$0{\cdot}50 \leqslant D < 0{\cdot}55$	45
$0{\cdot}55 \leqslant D < 0{\cdot}60$	38
$0{\cdot}60 \leqslant D < 0{\cdot}65$	32
$0{\cdot}65 < D < 0{\cdot}70$	28
$0{\cdot}70 \leqslant D < 0{\cdot}75$	24
$0{\cdot}75 \leqslant D < 0{\cdot}80$	21
$0{\cdot}80 < D < 0{\cdot}85$	19
$0{\cdot}85 \leqslant D < 0{\cdot}90$	17
$0{\cdot}90 \leqslant D < 0{\cdot}95$	15
$0\ 95 \leqslant D < 1{\cdot}00$	14
$1{\cdot}00 \leqslant D < 1{\cdot}10$	13
$1{\cdot}1 < D < 1{\cdot}2$	11
$1{\cdot}2 \leqslant D < 1{\cdot}3$	10
$1{\cdot}3 \leqslant D < 1{\cdot}4$	8
$1{\cdot}4 < D < 1{\cdot}5$	8
$1{\cdot}5 \leqslant D < 1{\cdot}6$	7
$1{\cdot}6 < D < 1{\cdot}7$	6
$1{\cdot}7 < D < 1{\cdot}8$	6
$1{\cdot}8 \leqslant D < 1{\cdot}9$	6
$1{\cdot}9 \leqslant D < 2{\cdot}0$	5
$2{\cdot}0 < D$	5

NOTE — Table 1 is taken from DAVIES (O L) Ed. The design and analysis of industrial experiments, 1956, pp. 606-607, and lists values of n_r for D at $\alpha = 0{\cdot}05$ and $\beta = 0{\cdot}05$, where α is the chance of assuming a statistical difference when none exists (i.e., the significance level of the one-sided t-test) and β is the chance of assuming no statistical difference when a bias δ is present.

7 NUMERICAL EXAMPLES OF EXPERIMENT

7.1 The numerical examples of taking the bias of sampling under different situations are given in Annex B.

Table 2 Value of t at 5 Percent Level of Significance (One-Sided Test)

(*Clause* 6.4)

Number of Paired Sets of Measurements, k	t
20	1·729
21	1·725
22	1·721
23	1·717
24	1·714
25	1·711
26	1·708
27	1·706
28	1·703
29	1·701
30	1·699
31	1·697
32	1·696
33	1·694
34	1·692
35	1·691
36	1·690
37	1·688
38	1·687
39	1·686
40	1·685
41	1·684
42	1·683
43	1·682
44	1·681
45	1·680
46	1·679
47	1·679
48	1·678
49	1·677
50	1·677
51	1·676
61	1·671
81	1·664
121	1·658
241	1·651
∞	1·645

ANNEX A

(*Clause* 4.3)

A-1 OVERALL PRECISION OF TEST RESULTS (β_{SDM})

A-1.1 When a lot or sub-lot of ore is sampled and a test result for a particular characteristic is obtained, it is affected by a number of variations. This result is taken to be the mean value of the lot or sub-lot and is generally represented by $\mu \pm \beta_{SDM}$, where β_{SDM} is the overall precision and μ is the mean value.

A-1.2 The three major components of overall precision are those relating to sampling (up to the stage of collecting gross sample), division (from gross sample to laboratory sample through various stages of sample preparation) and measurement (precision of test method, especially repeatability).

The following equations are to be noted:

$$\beta_{SDM} = 2\,\sigma_{SDM}$$

$$\sigma_{SDM}^2 = \sigma_S^2 \pm \sigma_D^2 + \sigma_M^2$$

where σ_{SDM}, σ_S, σ_D and σ_M are standard deviations relating to overall precision, sampling, sample division and measurement, respectively.

A-1.2.1 For practical purposes, σ_{SDM} is the most useful parameter and it is directly derived from test results. But in order to control overall precision (β_{SDM}), it is necessary to estimate σ_S, σ_D and σ_M separately by means of statistical experiments.

A-1.2.2 σ_S is dependent on the number of increments, σ_D on the type of sample division and sampling equipment used and σ_M on the test method precision.

For example,

$$\text{if } \sigma_S = 0{\cdot}4,$$

$$\sigma_D = 0{\cdot}05, \text{ and}$$

$$\sigma_M = 0{\cdot}02$$

as obtained from experiments on a particular type of ore.

$$\sigma_{SDM}^2 = 0{\cdot}160\,0 + 0{\cdot}002\,5 + 0{\cdot}000\,4$$

$$= 0{\cdot}162\,9$$

$$\sigma_{SDM} = 0{\cdot}404\,0$$

$$\beta_{SDM} = 0{\cdot}808\,0 \simeq 0{\cdot}81$$

ANNEX B

(*Clause* 7.1)

B-1 EXAMPLE OF AN EXPERIMENT FOR CHECKING THE BIAS OF SAMPLING

B-1.1 Table 3 gives the results of Fe content obtained by two procedures of sampling on 20 sub-lots. Method A is stopped-belt sampling, while Method B is based on drawing increments through a bypass belt. 20 sub-lots are subjected to both the methods of sampling.

B-1.2 Verify whether the number of experiments are sufficient to detect a bias (in sampling) of 0·2% Fe content. In case, the number of experiments conducted are not found sufficient, carry out additional experiments and test the significance of bias. The assumed $\delta = 0{\cdot}2$.

$$\bar{d} = \frac{1}{k}\,\Sigma d_i = \frac{2{\cdot}03}{20} = 0{\cdot}101\,5$$

$$SS_d = \Sigma d_i^2 - \frac{1}{k}\,(\,\Sigma d_i\,)^2 = 2{\cdot}454 - \frac{(\,2{\cdot}03\,)^2}{20}$$

$$= 2{\cdot}454\,7 - \frac{4{\cdot}120\,9}{20}$$

$$= 2{\cdot}454\,7 - 0{\cdot}206\,0$$

$$= 2{\cdot}248\,7$$

$$S_d = \sqrt{SS_d/\,(\,k-1\,)} = \sqrt{\frac{2{\cdot}248\,7}{19}}$$

$$= 0{\cdot}344\,0 \simeq 0{\cdot}344$$

Thus,

$$D = \frac{\delta}{s_d} = \frac{0{\cdot}2}{0{\cdot}344} = 0{\cdot}581$$

Table 3 Results of Fe Content Obtained by Two Methods of Sampling

(*Clause* B-1.1)

Sl No. of Sub Lot	Total Iron Content (Fe) (Percent)		$d_i = x_{Ai} - x_{Bi}$	d_i^2
	Method A x_{Ai}	Method B x_{Bi}		
1	66·79	66·79	0	0
2	65·44	65·56	− 0·12	0·014 4
3	67·19	67·13	+ 0·06	0·003 6
4	67·30	67·72	− 0·42	0·176 4
5	65·46	65·14	+ 0·32	0·102 4
6	67·02	66·53	+ 0·49	0·240 1
7	67·02	67·04	− 0·02	0·000 4
8	67·16	67·52	− 0·36	0·129 6
9	67·11	68·00	− 0·89	0·792 1
10	67·13	67·43	− 0·30	0·090 0
11	67·49	67·82	− 0·33	0·108 9
12	67·54	68·00	− 0·46	0·211 6
13	65·90	66·20	− 0·30	0·090 0
14	67·83	67·68	+ 0·15	0·022 5
15	66·04	65·73	+ 0·31	0·096 1
16	67·70	68·09	− 0·39	0·152 1
17	66·91	67·14	− 0·23	0·052 9
18	65·57	65·17	+ 0·40	0·160 0
19	67·69	67·59	+ 0·10	0·010 0
20	65·85	65·89	− 0·04	0·001 6
			+ 2·03	2·454 7

B-1.3 From Table 1, $n_r = 38$ is obtained. Therefore, an additional set of experiments should be undertaken and then the significance test carried out on a total of 38 data sets.

Accordingly, 18 more sub-lots were subjected to both the methods of sampling, namely, Method A and Method B. The results for the additional experiments conducted are given in Table 4.

Calculations for the combined data for 38 experiments

$$\bar{d} = \frac{-1{\cdot}13 + 2{\cdot}03}{38} = \frac{0{\cdot}90}{38} = 0{\cdot}023\ 7$$

$$SS_d = \Sigma d_i^2 - \frac{1}{k}(\Sigma d_i)^2 = 4{\cdot}668\ 8 - \frac{(0{\cdot}9)^2}{38}$$

$$= 4\ 668\ 8 - \frac{0{\cdot}810\ 0}{38}$$

$$= 4{\cdot}668\ 8 - 0{\cdot}021\ 3$$

$$= 4{\cdot}647\ 5$$

$$s_d = \sqrt{SS_d/(k-1)} = \sqrt{\frac{4{\cdot}647\ 5}{37}}$$

$$= 0{\cdot}354\ 4 \simeq 0{\cdot}354$$

$$t_0 = \frac{\bar{d}}{s_d / \sqrt{k}} = \frac{0{\cdot}023\ 7}{0{\cdot}354/\sqrt{38}} = \frac{0{\cdot}023\ 7}{0{\cdot}057\ 4}$$

$$= 0{\cdot}412\ 9$$

t, the table value for 37 d.f. at 5% level of significance (one-sided test) is 1·687.

Since $t_0 < t$, the bias is not significant.

Hence Method B can be used in place of Method A.

Table 4 Results of Fe Content for the Additional Experiments

(*Clause* B-1.3)

Sub-Lot No.	Total Iron Content (Fe) (Percent)		$d_i = x_{Bi} - x_{Ai}$	d_i^2
	Method A x_{Ai}	Method B x_{Bi}		
1	67·16	67·19	+ 0·03	0·000 9
2	66·75	66·50	− 0·25	0·062 5
3	66·91	66·84	− 0·07	0·004 9
4	66·74	65·96	− 0·78	0·608 4
5	67·24	66·74	− 0·50	0·250 0
6	65·68	65·62	− 0·06	0·003 6
7	66·93	67·08	+ 0·15	0·022 5
8	67·02	67·11	+ 0·09	0·008 1
9	67·13	66·85	− 0·28	0·078 4
10	66·07	65·54	− 0·53	0·280 9
11	67·21	67·03	− 0·18	0·032 4
12	67·11	66·93	− 0·18	0·032 4
13	67·21	67·42	+ 0·21	0·044 1
14	67·54	67·74	+ 0·20	0·040 0
15	67·24	67·91	+ 0·67	0·448 9
16	67·63	67·62	− 0·01	0·000 1
17	67·04	67·56	+ 0·52	0·270 4
18	67·35	67·19	− 0·16	0·025 6
			− 1·13	2·214 1

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference:

Doc : No. BS 7 (280)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110002
{ 331 01 31
{ 331 13 75

Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola
CALCUTTA 700054
87 86 62

Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036
53 38 43

Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113
41 29 16

Western : Manakalaya, E9 MIDC, Marol, Andheri (East)
BOMBAY 400093
632 92 95

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR.
COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD.
JAIPUR. KANPUR. LUCKNOW. PATNA. THIRUVANANTHAPURAM.

Printed at New India Printing Press, Khurja, India